Sensitive Question Techniques in Online Surveys

An Experimental Comparison of Different Implementations

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Outline

- Sensitive questions in survey research
- Some indirect approaches to elicit truthful answers
  - The Randomized Response Technique (RRT)
  - The Crosswise Model: A new alternative to RRT
- Experimental comparison of the different approaches
- Conclusions

Eliciting truthful answers to sensitive questions – not an easy task

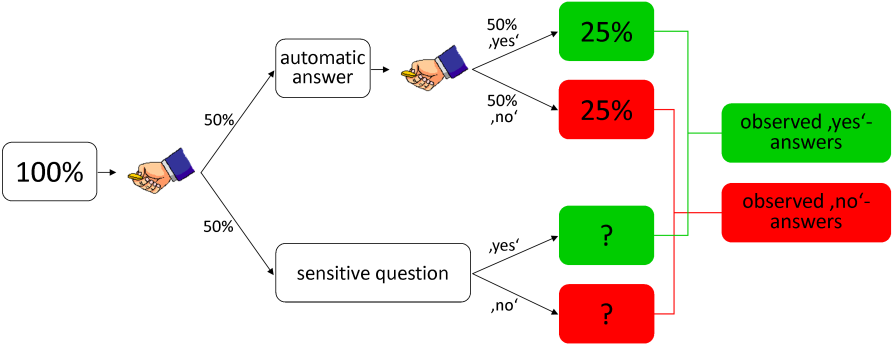
- Survey respondents might not always tell the truth if asked about sensitive topics. This leads to distorted results (social desirability bias).
- Some examples for proportion of "liars" (respondents with a false negative response) in surveys that use direct questioning (estimates from validation studies):
  - Penal conviction: 42.5% (F2F, Wolter 2010)
  - Welfare and unemployment benefit fraud: 75% (F2F, van der Heijden et al. 2000)
  - Driving under influence: 54% (P&P, Locander et al. 1976)
  - Bankruptcy: 32% (P&P, Locander et al. 1976)

The Randomized Response Technique (RRT)

(Warner 1965; Fox and Tracy 1986)

- Main principle: privacy protection through randomization (i.e. add random noise to the answers)
- A *randomizing device*, the outcome of which is only known to the respondent, decides whether ...
  - the sensitive question has to be answered
  - or an automatic "yes" or "no" has to be given or a surrogate question has to be answered
- Since only the respondent knows the outcome of the randomization device, a "yes" cannot be interpreted as an admission of guilt.
- However, if the properties of the randomizing device are known, a prevalence estimate for the sensitive question can be derived.

Example (forced response RRT)



- Prevalence estimate:
  - $\Pr(\text{observed yes}) = \Pr(\text{sensitive question}) \cdot \pi + \Pr(\text{automatic yes})$
  - $\pi = \dfrac{\Pr(\text{observed yes}) - \Pr(\text{automatic yes})}{\Pr(\text{sensitive question})}$

The Crosswise Model (CM): A new alternative to RRT

(Yu, Tian, and Tang 2008)

- Very simply idea: Ask a sensitive question and a nonsensitive question and let the respondent indicate whether . . .
  - the answers to the questions are the **same** (both "yes" or both "no")
  - the answers are **different** (one "yes", the other "no")

		nonsensitive question: no	nonsensitive question: yes
sensitive question	no	**same**	**different**
	yes	**different**	**same**

  - Note: Questions must be uncorrelated and probability of "yes" must be unequal 0.5 for the nonsensitive question.

The Crosswise Model (CM): A new alternative to RRT

(Yu, Tian, and Tang 2008)

- Prevalence estimate:
  - $\Pr(\text{same}) = (1-\pi)\cdot(1-\Pr(\text{nonsensitive yes})) + \pi\cdot\Pr(\text{nonsensitive yes})$
  - $\pi = \dfrac{\Pr(\text{same}) + \Pr(\text{nonsensitive yes}) - 1}{2\cdot\Pr(\text{nonsensitive yes}) - 1}$
  - Note: Crosswise Model is formally identical to Warner's original RRT model.

Performance of RRT and Crosswise

- RRT does not seem to work well in online surveys
  - Lower prevalence estimates than with direct questioning or even negative prevalence estimates (Coutts et al. forthcoming, Holbrook/Krosnick 2010, Coutts/Jann 2011)
  - Same prevalence estimates as with direct questioning (Coutts/Jann 2011, Peeters 2006, Snijders/Weesie 2008)

Performance of RRT and Crosswise

- Reasons for failure of RRT
  - low respondents' understanding of RRT's principle 'protection through randomization', no trust in RRT
  - reluctance of respondents to give a forced/automatic 'yes' answer (Edgell et al. 1982, Lensvelt-Mulders/Boeije 2007)
  - self-protective 'no'-bias: to be on the save side, the dominant strategy is to answer always 'no' (Jann et al. forthcoming)
  - no suitable randomizing device for online use (e.g. at immediate disposition, no mode shift, trustworthy)

Performance of RRT and Crosswise

- The Crosswise Model seems to work better
  - higher prevalence estimates than with direct questioning in a p&p survey on plagiarism (Jann et al. forthcoming)
  - however, no empirical application in online mode so far
- Advantages of the Crosswise Model over RRT
  - easier to understand
  - no need for a randomizing device
  - no obvious self-protective answering strategy (e.g. always say 'no')

Our study

- Web-Survey among students of University of Bern and ETH Zurich in Spring 2011
- Response rate 33%
- Comparing direct questioning to three variants of RRT and two variants of the Crosswise Model
- Sensitive questions on
  - copying from other students in exam (`copy`)
  - using crib notes in exam (`notes`)
  - taking drugs to enhance performance on exam (`drugs`)
  - partial plagiarism (`partial`)
  - severe plagiarism/ghostwriting (`severe`)

Comparison of 6 experimental conditions

- Direct questioning
  - *example*
- forced response RRT using virtual random wheel
  - *example*
- forced response RRT using "pick a number" method
  - *example*
- RRT using Benford distribution and innocuous questions
  - *example part 1*
  - *example part 2*
- Crosswise Model using innocuous questions
  - *example*
- Crosswise Model using "pick a number" method
  - *example*

Breakoffs, response time, repondents' experience

	N	Breakoff	Time	Comply	Protect	Underst.
Direct questioning	1005	1.6	43			
RRT random wheel	1007	3.6	188	95.1	56.9	60.4
RRT pick a number	1019	3.8	183	92.4	67.4	66.2
RRT Benford	1001	2.9	165	94.8	61.7	57.3
CM unrelated question	1006	3.2	149	97.1	67.5	62.2
CM pick a number	1009	4.0	190	95.7	75.0	65.6

N: Number of assigned respondents
Breakoff: % who did not complete survey after reaching the sensitive questions
Time: Median total time (seconds) to answer the sensitive questions
Comply: % who think they complied with the instructions
Protect: % who think their answers are protected by RRT/CM
Underst.: % who think they understood why RRT/CM protects their answers

Prevalence estimates by condition

	copy	notes	drugs	partial	severe
Direct questioning	17.6	8.8	3.4	2.5	1.5
	(1.2)	(0.9)	(0.6)	(0.6)	(0.5)
RRT random wheel	23.5	11.2	-1.0	1.3	0.7
	(2.2)	(2.0)	(1.7)	(2.0)	(2.0)
RRT pick a number	17.8	14.1	-1.7	3.1	-4.8
	(2.1)	(2.0)	(1.7)	(2.1)	(1.8)
RRT Benford	17.5	13.1	4.5	8.1	2.4
	(1.9)	(1.8)	(1.6)	(2.0)	(1.8)
CM unrelated question	30.0	19.3	15.2	7.8	6.3
	(2.9)	(2.8)	(2.8)	(3.1)	(3.0)
CM pick a number	24.4	10.6	4.8	8.6	-0.4
	(2.8)	(2.6)	(2.5)	(2.9)	(2.7)
Observations	5734	5735	5719	4232	4230

Standard errors in parentheses

Prevalence estimates aggregated

	copy	notes	drugs	partial	severe
Level					
DQ	17.6	8.8	3.4	2.5	1.5
	(1.2)	(0.9)	(0.6)	(0.6)	(0.5)
RRT	19.6	12.8	0.6	4.2	-0.5
	(1.2)	(1.1)	(1.0)	(1.2)	(1.1)
CM	27.2	14.9	10.0	8.2	3.0
	(2.0)	(1.9)	(1.9)	(2.1)	(2.0)
Difference					
RRT - DQ	2.0	4.0**	-2.8*	1.6	-2.1
	(1.7)	(1.4)	(1.1)	(1.3)	(1.2)
CM - DQ	9.6***	6.2**	6.6***	5.7**	1.4
	(2.3)	(2.1)	(2.0)	(2.2)	(2.1)
N	5734	5735	5719	4232	4230

Standard errors in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Determinants of sensitive behavior

Randomized response logistic regression (see appendix)

	copy	notes	drugs	partial	severe
Perceived prevalence	0.054***	0.043***	0.042***	0.050***	0.069***
	(0.003)	(0.003)	(0.006)	(0.006)	(0.013)
Perceived risk	-0.018***	-0.033***		-0.003	-0.014
	(0.005)	(0.007)		(0.005)	(0.014)
Risk attitude	0.069*	0.080*	0.147*	0.060	0.128
	(0.031)	(0.034)	(0.063)	(0.067)	(0.130)
RRT	0.201	0.484**	-0.175	0.825*	-0.248
	(0.142)	(0.165)	(0.336)	(0.338)	(0.656)
CM	0.853***	0.847***	0.963**	1.571***	0.140
	(0.173)	(0.198)	(0.312)	(0.357)	(1.240)
Constant	-3.518***	-3.683***	-5.058***	-4.967***	-5.644***
	(0.247)	(0.282)	(0.472)	(0.548)	(0.971)
N	5695	5692	5681	4186	4186

Standard errors in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Summary of the study

- Crosswise Model clearly outperforms direct questioning (if we are ready to accept the "more-is-better assumption").
  - An exception is the last item (severe plagiarism), where prevalence is very low for all techniques.
- RRT, on the other hand, does not yield higher estimates than direct questioning
  - A reason might be the "self-protective no" bias, which prevents respondents to say "yes" if advised to do so by the randomizing device.

Methodological conclusions

- The Randomized Response Technique does not seem to be a good method for self-administered surveys. Although we put a lot of effort into pretesting and finding good implementations, no convincing evidence could be found that RRT yields more valid estimates than direct questioning. (With RRT "Benford" performing somewhat better than the other RRT implementations.)
- The Crosswise Model is a promising alternative, since it does not suffer from some of the deficiencies of the RRT ("self-protective no" bias, complexity).
- Improvement of RRT estimates is possible by correcting for cheating respondents who do not comply with the instructions (not shown; see appendix). Such estimates, however, have low efficiency.

Substantive conclusions

(based on combined results from Crosswise Model)

- A substantial proportion of students have cheated on an exam (copying: about 25 percent, crib notes: about 15 percent)
- Using drugs to enhance performance on exams is not uncommon (10 percent)
- Rates for partial plagiarism (using a passage from someone else's work without providing proper citation) are 8 percent. The prevalence of severe plagiarism (hand in someone else's work) is 3 percent.
- These numbers may not seem too high, but keep in mind:
  - There is lots of nonresponse, and probably mostly the "nice guys" participate.
  - Even with these low numbers we would expect at least 150 papers a year containing plagiarism and at least 50 papers, that are entirely falsified, at a small university with about 10000 students.

Thank you for your attention!

- Appendix
  - Generalized estimator for RRT and CM
  - Cheating detection in RRT
  - References

Generalized estimator for RRT and CM

- Let

  Y_i response ($Y_i = 1$ if "yes" in RRT or "A" in CM, else $Y_i = 0$)

  λ_i probability of $Y_i = 1$

  π_i (unknown) prevalence of sensitive item

  p_i^{w} probability of being directed to the negated question in Warner's RRT (or prevalence of nonsensitive item in CM)

  p_i^{yes} overall probability of surrogate "yes"

  p_i^{no} overall probability of surrogate "no"

- Then

$$\lambda_i = (1 - p_i^{\mathrm{yes}} - p_i^{\mathrm{no}}) p_i^{\mathrm{w}} \pi_i + (1 - p_i^{\mathrm{yes}} - p_i^{\mathrm{no}})(1 - p_i^{\mathrm{w}})(1 - \pi_i) + p_i^{\mathrm{yes}}$$

  and hence

$$\pi_i = \frac{\lambda_i - (1 - p_i^{\mathrm{yes}} - p_i^{\mathrm{no}})(1 - p_i^{\mathrm{w}}) - p_i^{\mathrm{yes}}}{(2p_i^{\mathrm{w}} - 1)(1 - p_i^{\mathrm{yes}} - p_i^{\mathrm{no}})}$$

Generalized estimator for RRT and CM

- Least squares estimator
  - Assume $\pi_i = X_i'\beta$ and estimate β using least squares with transformed response

$$\tilde{Y}_i = \frac{Y_i - (1 - p_i^{\text{yes}} - p_i^{\text{no}})(1 - p_i^{\text{w}}) - p_i^{\text{yes}}}{(2p_i^{\text{w}} - 1)(1 - p_i^{\text{yes}} - p_i^{\text{no}})}$$

- Logit estimator
  - Assume $\pi_i = e^{X_i'\beta}/(1 + e^{X_i'\beta})$ and estimate β using maximum likelihood with

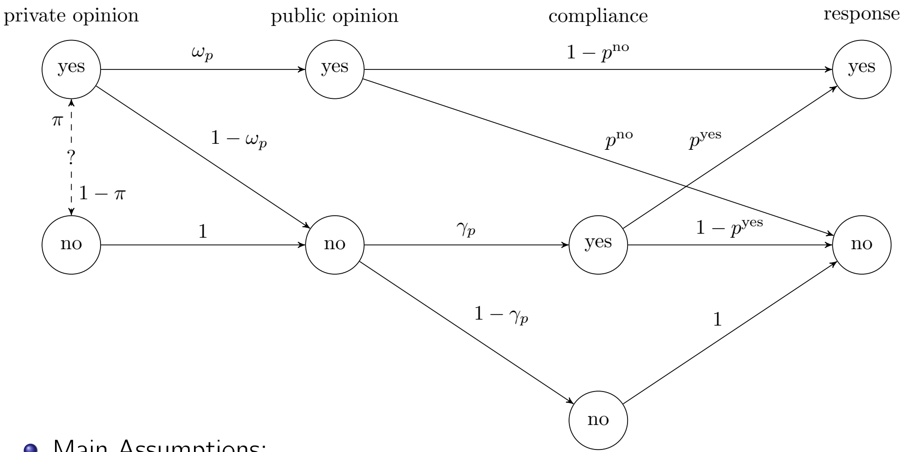
$$\ln L = \sum_{i=1}^{n} \left\{ Y_i \ln(R_i) + (1 - Y_i) \ln(S_i) - \ln(1 + e^{X_i'\beta}) \right\}$$

where

$$R_i = c_i + q_i e^{X_i'\beta} \qquad c_i = (1 - p_i^{\text{yes}} - p_i^{\text{no}})(1 - p_i^{\text{w}}) + p_i^{\text{yes}}$$

$$S_i = (1 - c_i) + (1 - q_i)e^{X_i'\beta} \qquad q_i = (1 - p_i^{\text{yes}} - p_i^{\text{no}})p_i^{\text{w}} + p_i^{\text{yes}}$$

Cheating detection in RRT



- Main Assumptions:
  - Monotonicity of social desirability: Public opinion is always "no" if private opinion is "no"
  - No provocation: Respondents do not say "yes" if advised to say "no"

Cheating detection in RRT

- Assuming that γ and ω do not depend on p^{yes} and p^{no} (which may be justified if variation in p is small) (and that γ does not depend on the private opinion), this leads to the following log likelihood:

$$\ln L = \sum_{i=1}^{n} Y_i \ln(\ell_i) + (1 - Y_i) \ln(1 - \ell_i)$$

  with

$$\ell_i = \pi_i \omega (1 - p_i^{\text{no}} - \gamma p_i^{\text{yes}}) + \gamma p_i^{\text{yes}}$$

- If p^{yes} and p^{no} are randomly varied between respondents, then $\pi_i \omega$ and γ are identified.

Cheating detection in RRT

	copy	notes	drugs	partial	severe
RRT adjusted	17.8	11.7	16.7	14.2	6.4
	(6.5)	(6.1)	(5.6)	(6.6)	(5.9)
Cheaters	-9.9	-5.6	88.7	53.9	34.2
	(36.0)	(31.7)	(36.8)	(40.0)	(31.5)
N	2860	2860	2854	2108	2107

Standard errors in parentheses

Unadjusted results for comparison:

	copy	notes	drugs	partial	severe
DQ	17.6	8.8	3.4	2.5	1.5
	(1.2)	(0.9)	(0.6)	(0.6)	(0.5)
RRT	19.6	12.8	0.6	4.2	-0.5
	(1.2)	(1.1)	(1.0)	(1.2)	(1.1)
CM	27.2	14.9	10.0	8.2	3.0
	(2.0)	(1.9)	(1.9)	(2.1)	(2.0)
N	5734	5735	5719	4232	4230

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